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Memoirs of [illegible] Zoölogy,
AT H[illegible]

ON SOMI[illegible]ITIES.

By [illegible]

Museum of Comparative Zoölogy, Cambridge, Mass.

With the compliments of

ALEXANDER AGASSIZ.

UNIVERSITY PRESS, CAMBRIDGE,
WELCH, BIGELOW, & CO.
May, 1876.

9

Memoirs of the Museum of Comparative Zoölogy,
AT HARVARD COLLEGE, CAMBRIDGE, MASS.
VOL. II. No. 9.

ON SOME INSECT DEFORMITIES.

BY DR. HERMANN A. HAGEN.

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NOTE.

The quarto publications of the Museum will hereafter be issued under the title of "Memoirs of the Museum of Comparative Zoölogy." In order not to commence a second series, the numbers of the Illustrated Catalogue already issued have been combined to form the first volumes of these Memoirs. Title-pages and tables of contents of the three volumes already completed are sent with the present number.

ALEXANDER AGASSIZ.

ON SOME INSECT DEFORMITIES.

In arranging the Lepidoptera of the collection, I found, among the insects brought home from Brazil by Professor L. Agassiz, a specimen of *Morpho Eurylochus* with the head of the caterpillar. The excellent condition of the large specimen induced me to compare all published observations of a similar deformity. These are few, and scattered in transactions not easily accessible. Therefore I concluded to reprint the full text for the two oldest known, and to give copies of the figures, together with those of *M. Eurylochus*. In the hope of having information about other similar cases, I published a provisional paper in the Stettin Ent. Zeit. (1872), p. 388, and I am indebted to Professor Zeller of Stettin, Professor Westwood of Oxford, Mr. M'Lachlan of London, and Dr. J. L. Leconte of Philadelphia, for additional information.

The rare and less known paper of Mr. C. Majoli, on a precocious development of *Bombyx Mori*, and the notice of two deformities of Coleoptera, seemed to me not out of place in this paper.

PERFECT INSECTS WITH THE LARVAL HEAD.

Phalæna heteroclita.

The well-known Danish naturalist, Professor O. F. Mueller, has described (1764) in his Fauna Fridrichsdalina, p. 47, No. 413, a new species of Noctua, found by himself at Fridrichsdal, a locality a few miles distant from Kopenhagen.

Phal. N. heteroclita subcristata, capite erucæ, antennis nullis: alis albis, lineis transversim undatis punctatisque marginalibus nigris. In Epilobio.

This description is verbatim, repeated by himself in his Prodromus Faunæ Danicæ (1776), p. 124, No. 1428.

In the Mém. de Mathém. et de Phys. présentés à l'Acad. R. des Sciences à Paris (1774), Vol. VI, pp. 508 – 511, pl. 1, Professor O. F. Mueller has given a detailed account of this most remarkable speci-

men, believing it to be a new and very curious species of Lepidopteron, with all the characters of the order, except that the head is exactly that of a caterpillar. In the same volume of the Mémoires, the editor (Préface, p. 8) believes it more prudent not to admit Mueller's insect as a new species, because a fact contrary to all hitherto known must be proved by a great number of observations before it can be adopted by the scientific world. Professor Beckmann, the reputed polyhistor from Goettingen, in his Physik. Oekon. Bibliothek, Vol. VI, p. 338, believes that Mueller's insect is only a deformity. A review of Mueller's paper in the Comment. Lipsiens. (Vol. XXI, p. 466) I have not seen.

The French paper is translated by the Rev. J. A. E. Goeze, in the 16th part of the Naturforscher (1781), pp. 203–212, pl. 1. The plate is of course the same as Mueller's plate, but somewhat inferior in execution. The translation, in some places at least, does not entirely agree with the original, as Goeze introduces some suppositions to explain more fully Mueller's words, which are not everywhere free from ambiguity. But it is to be remembered that Goeze had spoken of the whole with Mueller, at a visit paid to him by the latter in 1776. At that time the type was still present in the collection of the author, which was afterwards destroyed at the bombardment of Kopenhagen. In my Bibliotheca Entom. (Vol. I, p. 556) I stated that the insect was *Bombyx dispar*, which is apparently an error. Westwood (Introd., Vol. II, p. 356) calls it one of the Noctuidæ; and Lacordaire (Introd., Vol. II, p. 442), une Noctuelle. The insect is not mentioned in the general works of Borkhausen and Ochsenheimer, but Werneburg (Beitr. zur Schmetterl. kunde, Vol. I, p. 376), quotes it as *Bombyx monacha*, and there is no doubt that this determination is a correct one.

Mueller found the insect alive, quietly sitting on a stem of *Epilobium montanum*, on July 28, 1762, pinned it, and only became aware at home of the remarkable fact that the head of the caterpillar was still existing on the moth. Both Mueller and Goeze give as the date June 28, apparently erroneously, as in the paper it is twice stated that the insect lived ten days on the pin, until the 6th of August, when it died. From June 28 to July 6 there are only nine days.

The description by Mueller is as follows:

Nearly the size of *Phal. vinula;* upper wings white, with several transverse zigzag lines, the border spotted with black; hind-wings smaller, grayish, the border with alternate black and white spots; all the wings blackish underneath, the border spotted with black; abdomen black, somewhat hairy, with five yellow rings, which are broad above, narrower beneath, and twice interrupted; the tip of the abdomen pointed, yellow, with a yellow ovipositor; the prothorax densely covered with white hairs, sprinkled with black; the thorax with four legs, black and gray-colored; the tibia with two spurs on the inside.

"La tête" (I give purposely Mueller's words), "cette étrange partie, est grisâtre et arrondie, plate au devant; elle est composée, comme le sont ordinairement les têtes de chenilles, de deux lobes latéraux, grisâtres et pointillés en noir, lesquels se joignant par-dessus, laissent au milieu une figure triangulaire et brune. C'est une membrane mince, qui à l'aide d'une loupe, laissait entrevoir une liqueur transparente, agitée d'un mouvement continuel. Il y a au bas du triangle deux petits corps ovales, qui avancent sur deux organes noirs, lesquels se répondent exactement et se choquent, au milieu de l'embouchure, comme deux marteaux. On voit à côté deux organes émoussés de couleur jaune, qui dans les chenilles sont communement garnis d'un poil fin, ce qui manque ici; plus bas, il s'avance des côtés deux crochets coniques et jaunâtres qui se touchent au milieu de la bouche; à l'entour on voit quelques taches incarnates et grandes; plus a côté quelques points brillants et par-ci par-là quelques petits brians de poils."

The moth lived ten days, and deposited a number of green eggs, most of them on the first and second days, some on the latter days up to the 6th of August, when it died. The eggs were not developed.

Mueller repeats a second time (p. 511): "On voit clairement le mouvement peristaltique de la liqueur sous la membrane triangulaire, aussi bien que le mouvement des organes de la bouche; il ne s'en trouve pas la moindre trace des antennes et trompe."

It would not be justifiable to consider this statement pure and simple an error, inasmuch as Mueller was undoubtedly one of the most prominent naturalists, and must have known very well the importance of the described facts. If the statement of Mueller is accepted as correct, the specimen is an exception, and differs considerably from all others as yet recorded. It must have been an imago, with the head of the caterpillar preserved; not only with the skin covering the head of the imago preserved, but with a real head of the caterpillar, in which the circulation of the blood is still taking place, and the maxillary organs are still movable. Such a condition of the parts is contrary to all our present knowledge of the anatomy and the development of insects. It is remarkable that the forelegs have not been developed, as the superior part of the prothorax is similar to that of the imago. But Mueller records and figures only the four posterior legs.

The opinion of Mueller, that his moth represents a new and somewhat intermediate genus and species, is of course an erroneous one. The supposition by Kirby and Spence, Introd., Vol. III, p. 121 (transl. Oken), that the head was damaged perhaps in the caterpillar state by some parasite, and the caterpillar therefore was unable to cast off its skin, needs no refutation. I cannot give any probable explanation of the fact; perhaps it was a monstrosity, never observed but in this isolated specimen.

Mueller's observation was accepted by the prominent naturalists of the time, — for instance, by Bonnet. Later J. F. Meckel (Handb. der pathol. Anatom., Vol. I, p. 55) explained the fact as an arrested development of the insect. Dr. Stannius (Mueller's Archiv., 1835, p. 296) accepts this explanation. J. van der Hoeven (Tijdskr. voor natuurl. Gesch., Vol. VII, p. 274) believes the case to be just like that of Wesmael and rejects the opinion of Mueller concerning the head; but I think he has not given strict attention to Mueller's statements.

Nymphalis Populi.

Professor Wesmael gives in Bull. Acad. Bruxelles, 1838, Tom. IV, p. 359, reproduced partly in Ann. Scienc. Nat., Ser. 2, Vol. VIII, p. 191, a description and colored figure of this insect. If I am not mistaken, I saw, in 1870, the type in the Museum in Brussels. He caught the specimen in July, near this city. The insect had the thorax, abdomen, legs, and wings perfectly well developed and colored, but with the head of the caterpillar. The insect turned the curious head to the right and left, and tried, by a quick motion of the forelegs, to push it off. Mr. Wesmael, in dissecting the left side of the head, discovered underneath the external skin a second one much thinner than the first, and beneath the second one the well-developed eye of the butterfly. The parts around the eye were covered, as commonly, with scales. Therefore Wesmael considers the second skin as that of the chrysalis, and believes the deformity originated by the inability of the caterpillar to cast off the head.

Underneath the head of the caterpillar, and just above the skin of the chrysalis, was the left antenna, coiled up, but without an apical knob. The antenna was covered by a very fine membrane, which was to a great extent diaphanous, and transversely striated with brown. The left palpus was free, normally developed, and turned horizontally backwards. The right palpus seemed broken off; the place of its insertion was clearly visible. Mr. Wesmael says nothing about the prothorax; as the forelegs were free and movable, it must have been without any covering.

This butterfly differs essentially from the moth described by Mueller. The head shows only the skin of the caterpillar, which really has gone through the transformation into the head of the chrysalis, and later into the head of the imago, retaining throughout the skin of the former stages, one above the other. The recorded movement of the head was apparently done by the movement of the head of the imago. Wesmael makes the following conclusions: —

1. The insects which are obliged to undergo transformation may have only a partial one, which does not prevent the total transforma-

tion of other parts; even if the untransformed parts are important to the life of the animal. He believes this to be a natural consequence of the segmentation of the body of the arthropods.

2. The accidentally covered parts nevertheless go through all transformations which are necessary for the insect to arrive at the imago state. The second conclusion is of course not to be accepted, if the facts recorded by Mueller are adopted.

Morpho Eurylochus.

Among about a dozen specimens of this butterfly brought home by Professor L. Agassiz from Brazil, one male has retained the head of the caterpillar. The specimens are from Canta Gallo, communicated by Dr. Teuscher. Their perfect condition leads me to suppose they were reared from the chrysalis.

The quoted male is in perfect condition, and, as all others, entirely well developed in size and in colors. The head of the caterpillar is retained and perfectly preserved in shape and in color; the minute yellow hairs which cover the head are in good condition, and the spines are scarcely crumbled. Beneath the head the mentum is broken off near the prothorax. Its lateral sutures are separated, and the mentum hangs down as a kind of trap-door, being united with the head only by a small anterior lobe. This kind of adjustment leads me to suppose that the mentum was broken by the pushing out of the spiral tongue of the imago. The opening is large enough to show that the head of the caterpillar is empty inside. The skin between the head and the prothorax is still preserved in the shape of a contracted ring, which is open only for a small space beneath, where the mentum is separated. The large dorsal plate of the prothorax is present, and covers loosely the thorax of the imago; on the left side the external third is wanting. The palpi are rejected to the thorax, but the right palpus has the two basal thirds covered by the skin of the caterpillar, which is connected with the dorsal part of the prothorax. Behind the palpus and rather near to it can be seen the free foreleg of the right side. Its limbs are well developed, neither as stout nor as hairy as in the other specimens. The left palpus, though not covered, seems to be shorter and less hairy than the right one. The left foreleg is covered by the femur of the middle leg. I am not able to state whether any part of the skin of the chrysalis, either beneath the dorsal plate of the prothorax on the middle and on the right, or on the entirely free left side of the thorax, is present. Perhaps the skin of the chrysalis is broken off just at the ring formed between the head and the prothorax. I am unable to see the skin of the chrysalis inside of the head of the

caterpillar through the small opening of the mentum. As the skin of the chrysalis must have existed, I did not deem it necessary to dissect the specimen, especially as Wesmael's dissection of *Nymphalis Populi* has sufficiently explained the fact.

The head of the caterpillar resembles very much the figure in Merian Surinam. Lepid., pl. 23. The color is leather-yellow, with two brown bands on each side. There are two yellow finger-shaped horns on the top, and three similar ones on each side; they become successively smaller. The last one is very short.

The specimen has doubtless lived long enough to get the colors perfectly developed, and to break down the mentum with the spiral tongue. It differs from Wesmael's butterfly in having retained the dorsal part of the prothorax, though somewhat distant to allow a view of the thorax of the imago. In Wesmael's butterfly the palpi were not covered. I have quoted erroneously, in the Proceed. Bost. Soc. N. H., 1868. Vol. XII, p. 163, the Brazilian specimen as *Morpho Ilioneus*, and Mueller's specimen as *Dicranura vinula*.

Vanessa Antiopa.

Professor Zeller has described in the Isis, 1839, p. 259, a specimen with the head of the caterpillar, raised by himself together with about 150 others. The specimen differs from them only by the presence of the head of the caterpillar, which is in a vertical position, just as in the caterpillar. The mouth is closed. Having cut a part of the left side, the Professor could observe a hollow space between the head of the caterpillar and the remaining parts of the insect. Behind the head and not connected with it the two anterior plates of the chrysalis are retained. The butterfly made its transformation in the absence of the Professor, and was pinned at the same time with all the others. It was impossible to find its chrysalis skin.

Vanessa Atalanta.

Mr. Bond exhibited in the Entomological Society in London, February 6, 1871, a specimen bred by a metropolitan collector, which still bore the larval head. The specimen, as I am informed by Mr. M'Lachlan, was very perfect.

Pieris Rapæ.

Among a number of chrysalids which had not transformed, I found in the fall of 1871, in Cambridge, one of an extraordinary appearance. In casting off the skin of the caterpillar only the thoracic part of the

chrysalis was developed; the head of the caterpillar was still present, but its sutures were separated. The dorsal split of the skin reaches the first segment of the abdomen, and the skin of the abdomen is retracted, but still present.

A similar specimen was observed last fall by Mr. S. H. Scudder.

Zygæna exulans var. Vanadis.

Dr. Staudinger, in a paper on the Lepidoptera of Lapland in Stett. Entom. Zeit., 1861, Vol. XXII, p. 359, records a larval-headed male of this species, found, July 11, near Bossekop. The specimen is fully developed, with the head of the caterpillar. The mouth parts were immovable in the living insect; the head was fastened to the prothorax, and moved only by the motion of the prothorax. The latter is fully developed beneath, and with its legs; above there is a horny black vaulted ring, somewhat hairy on the left side. Mr. Staudinger believes it impossible that the head of the imago is enclosed in this larval head.

Sphinx spec.

Mr. Trouvelot assured me that he had caught in Cambridge several years ago, a Sphinx with the head of the caterpillar. The specimen is no longer in existence.

Professor Van der Hoeven, in his quoted paper, p. 274, records that he has seen a caterpillar of *Sph. Tiliæ* which had not been able to cast off in the last moult the skin covering the spine of the tail. The caterpillar died before the transformation.

Bombyx Mori.

Mr. J. J. Bruinsma, in Tijdschrift voor Natuurl. Geschied, 1840, Vol. VII, pp. 257–270, pl. 1, has published detailed observations concerning the same deformity, accompanied by figures.

Having read Wesmael's paper, Mr. Bruinsma concluded to try his own observations in raising silk-worms. In the course of the summer he found some specimens, which did not agree exactly with Wesmael's butterfly, but seemed interesting for publication. But shortly after Mr. S. Van Leuwen, also interested in the same kind of observations, communicated to him, August 9, a chrysalis with the upper part of the larval head still remaining. The chrysalis was fourteen days old, and had been taken out of a cocoon, in which the skin of the caterpillar was found. The skin showed nothing unusual, except that the head, which commonly remains united with the skin, was broken off.

The chrysalis was of medium size, rather lively, and perfectly developed. To the upper part was fastened with a collar the caterpillar's head, split in two lateral parts, which are united together in the common caterpillar head. The mouth parts of the caterpillar were still remaining, but between them another prolongation could be seen. The nympha is figured in different views, Figs. 1 – 4.

The chrysalis transformed, August 26, into a moth with the caterpillar head. The chrysalis had the skin split as usual on the dorsal part. So the moth left the chrysalis in the usual way, and was perfectly developed (Fig. 5), except that the right foreleg was smaller than the left one, but otherwise well formed. Therefore the moth stood somewhat obliquely. It was a male, rather lively in his movements, and used both forelegs to push off the caterpillar head, by which it was seemingly annoyed. The head of the caterpillar covered exactly the place where the head of the moth should be, so that nothing was to be seen of it, nor of its antennæ or eyes. On the prothoracic border the same elongated part was to be seen as in the chrysalis, without any hairs, consisting only of a brownish membrane The side parts of the head were fastened to it just as in the chrysalis. The right part was taken off, and beneath it the right antenna was discovered, well formed, but coiled up. In taking off more of the skin, a well-formed eye of the perfect insect appeared.

Mr. Bruinsma explains the fact by the difference of the last moult from the four preceding ones. He states that in the last moult the skin splits near the tail, and the chrysalis comes out backwards, by which process the head is sometimes not able to follow. I confess that this statement is entirely new to me, and disagrees with Malphigi's description.

Mr. Bruinsma concludes his paper with some observations made on caterpillars which, after having spun the cocoon, were taken out and obliged to spin a second cocoon. This was only imperfect, so that a full observation of the caterpillar was possible. Mr. Bruinsma observed that one of them formed a chrysalis with the head of the caterpillar. But the chrysalis died very soon. Two of the caterpillars are figured.

Professor J. Van der Hoeven has published a paper in the same journal, following that by Mr. Bruinsma, pp. 271 – 275, about perfect Lepidoptera with the larval head remaining. He draws attention to an old observation by J. Jonston, published in his Hist. Natur. de Insectis, Amstelod, 1657, p. 123 (Edit. Heilbr., 1768, p. 176). The account by J. Jonston is very detailed, and concerns a male and a female of *B. Mori*. The male was in the chrysalis state, the anterior part covered with the parts of the caterpillar. The imago was not able to cast off the skin, died, and was dissected. The head of the imago was found to be fully developed.

The female showed perfectly well the head of the caterpillar, and beneath it the skin of the chrysalis, containing the head of the imago.

"Itaque ibi senectæ caput [head of the caterpillar], nymphæ vertex et necydali [imaginis] conjuncta conspiciebantur; quæ conjunctio retinebat senectam [skin of the caterpillar] in ventre, ne potuerit potius avelli et destringi. Ideo et cohærebat, cum alvi acumine, non aliter ac si quis sacco fuit inclusus; et circa caput astrictus; facto vero in tergo foramine dorsum extraxisset quidem, sed adhuc hæreret capite et podice, ita jacens incurvus et exanimis. Sic habebat senecta (the caterpillar]. Ex hac prominebat et aurelia [chrysalis], quod attinet partem superiorem. Ex aurelia vicissim necydalus [imago] fere totus eluctatus erat, fracto putamine in dorso, solitaque regione; sed capita cohærebant indivulsa, sicut et alvi extrema. In ventro exorto magna copia ovorum conspiciebatur colore flavo."

The statement of the skin of the caterpillar split on the dorsum disagrees with the statement by Mr. Bruinsma.

Professor Van der Hoeven (ibid., p. 274) communicates, in a letter to Mr. A. Brants, November 26, 1839, that Mr. Einodhven, in his silk-worm nursery at Brummen, Holland, had observed several times imagines with the head of the caterpillar. Mr. Brants was able to take out of one of them the perfectly developed head of the imago. The antennæ were coiled up, covering the eyes of the insect.

Mr. Bond exhibited in the Entomological Society in London, February 20, 1871, a specimen of *B. Mori* retaining the larval head. The specimen was somewhat crippled and very small, as I am informed by Mr. M'Lachlan.

Gastropacha quercifolia.

A specimen with the larval head is recorded by Professor Westwood in Entomol. Month. Magaz., No. 82, p. 239.

Zerene adusta.

I am indebted to Professor Zeller for the details of this. Among a number of caterpillars of this species, one transformed in a chrysalis, with the head of the caterpillar. The chrysalis died, perhaps because it was kept too dry. Otherwise probably a moth would have been reared, as the chrysalis was perfectly developed. The head of the caterpillar was in perfect condition, but placed so far beneath that the chrysalis had a hunchbacked appearance. The face and the ventral side met in an acute angle; a collum was wanting, but the head was round, separated more deeply below. As all parts of the head of the chrysalis are covered by the head of the caterpillar, there are no an-

tennal covers visible. The furrow in which the antennæ should have been placed begins very shallow on the prothorax, near the head, and runs between the front margin of the anterior wings and the hind legs, somewhat longer on the right side. This furrow is largest along the tibia. The covers of the palpi and the tongue are wanting.

Botys fuscalis.

Mr. Stainton exhibited in the Entomological Society in London, a specimen with the head covered by a part of the puparium, caught on the Isle of Man. It was flying briskly when captured, and was otherwise perfectly developed. The antennæ and the haustellum were free, and the case of the latter projected downwards like the rostrum of a Panorpa. I am indebted to Mr. M'Lachlan for the communication of this case.

Of insects not belonging to Lepidoptera, only four with a similar deformity are known.

Cybister limbatus.

Mr. Smith (Proceed. Entom. Soc., London, Ser. 2, Vol. IV, p. 34) exhibited a specimen with the larval head, caught swimming near Hongkong in China.

Dytiscus marginalis.

Professor Westwood (the Entom. Month. Mag., No. 82, p. 239) stated that he had seen a specimen with a larval head.

Hydaticus bimarginatus.

I am indebted to Dr. John L. Leconte for the information that a specimen of this beetle, with the larval head, is in the collection of Dr. Helmuth in Chicago.

Syrphus spec.

Professor Westwood (ibid.) states that he had observed one specimen with a larval head.

I am indebted to the same professor for the communication that he is about to publish a dozen cases of perfect insects with the larval head, all of which he has figured.

The specimens mentioned above are: —

Lepidoptera. — 1. Vanessa Atalanta.
2. Vanessa Antiopa.
3. Nymphalis Populi.

4. Pieris Rapæ.
5. Morpho Eurylochus.
6. Zygæna exulans.
7. Sphinx spec.
8. Bombyx Mori (several times).
9. Liparis Monacha.
10. Gastropacha quercifolia.
11. Zerene adusta.
12. Botys fuscalis.

Coleoptera. — 13. Dytiscus marginalis.
14. Hydaticus bimarginatus.
15. Cybister limbatus.

Diptera. — 16. Syrphus spec.

Only the fact of the presence of the larval head is known for the Nos. 7, 10, 13 – 16. More or less sufficient details are known for Nos. 1, 3, 8, 12, but the publication by Professor Westwood will give doubtless a full information about them. The Nos. 4, 11, were only in the chrysalis state, and do not strictly belong here. But just those cases are interesting, as all the others must have passed the chrysalis state in the same manner.

The Nos. 1, 2, 8, and probably 5, were bred by home raising; Nos. 3, 6, 7, 9, 12, 15, were caught living.

The interesting fact that the larval head is sometimes retained in the perfect insect is proved by the quoted observations. Probably all cases except *Noctua heteroclita* belong to the same kind of deformity. The head of the imago is contained in the head of the larva, which the insect was not able to cast off in the transformation. It must be admitted that circumstantial details are known only for *V. Populi*, *V. Antiopa*, *M. Eurylochus*, *Z. exulans*. The prothorax of the two last-mentioned species, and even one foreleg in *M. Eurylochus*, is still covered by the larval skin. The antennæ are free in *B. fuscalis*; the palpi are rejected in *V. Antiopa*, *V. Populi*, *M. Eurylochus*; in *Z. exulans* they are free. All specimens were fully developed in size, shape, and colors, except *B. Mori*.

Perhaps such deformities are not so rare as the small number of known cases would lead us to believe. Such deformed specimens are more easily caught and destroyed by their natural enemies, or they die sooner for lack of food. Nevertheless, the very large number of Lepidoptera bred and raised during the past hundred years allows us to conclude that at least in home raising such deformities occur very rarely. Mr. Trouvelot observed many times *T. Polyphemus* caterpillars casting off the larval head with more or less difficulty, and sometimes not at all. The last case proved to be fatal. As insects of course are developed more easily in liberty than in captivity, the rare occurrence of perfect

insects retaining the larval head may depend on the larger mortality of their caterpillars.

There is very little known concerning the physiological and mechanical processes shortly before or during the act of transformation of arthropods. Nearly all entomological works state that the larvæ moult or change their skin several times, that the larvæ become restless some days before the change, stop eating, and desert their food; later, the skin splits, and the insect perfects its transformation.

I believe there exist few men who have not seen and observed once in their life this wonderful spectacle. The proceedings are so common, and always so easily performed, that observers are not induced to think about the manner in which transformation is effected, nor about the mechanical acts providing the possibility of such a change. Concerning the mechanical acts, so far as I know, nothing is published. An animal, or even a man, covered with an artificial skin well fitted to the whole body, obliged to go out of the skin through an aperture made of similar size and relation as that in insects, would scarcely be able to do it without a violent use of the limbs. Insects use their limbs very little or not at all in the beginning of transformation, but nature has provided some help in the necessary coincidence of certain physiological proceedings just at the time of transformation.

I have observed many times and in different insects, before transformation, a very accelerated and excited action of the dorsal vessel. The same fact is recorded by other observers, for instance by Mr. Weismann and Mr. W. Blasius. After observations of Mr. W. Blasius (Zeitschr. f. wiss. Zoöl., Vol. XVI, pp. 135 – 177), during the transformation of the caterpillar into the chrysalis, the action of the dorsal vessel increases successively in the first three hours, and reaches its maximum in the last half of the fourth; after that time the action begins to decrease, and becomes in the eighth hour equal to the action in the third hour. The consequence of an accelerated action of the dorsal vessel is an increased circulation of the blood, going from the tail to the head. This sudden rush of an unusual quantity of blood to the head and the thorax, without any corresponding arrangement for convenient emanation, swells those parts, pushing them forward at the same time. Finally the skin bursts, and one of the most important acts of the moult is performed.

I suppose that the frontal bladder, which is observed in transforming Diptera and Odonata, is the consequence of the rush of blood; nevertheless, an observation recorded by Weismann seems to disagree with such a supposition. It should not be overlooked that some other purely mechanical proceedings seem to accompany and help the propulsion of the insect by the rush of the blood in a very easy manner. I have described long ago a related fact in regard to the moult of Ephemera,

Stettin. Ent. Zeit. (1849), p. 365. The segments of the abdomen possess on each side an apical spine. By a continuous movement of the abdomen to the right and left, those spines press successively against the loosened skin, forcing forward the transforming insect. Probably similar arrangements will be found in other insects.

The causes why such a rush of blood originates just at the time of the moult, I find nowhere recorded. I think it not sufficient to consider it as a simple consequence of an action of the nervous system, especially as I believe myself able to give a more plausible explanation.

The crust of insects consists of the external chitinized epidermis, and the internal soft hypodermis. Above the latter, which becomes somewhat separated from the epidermis, the new skin is to be formed, at first without impediment to the functions of the insect. As long as the more or less isolated parts of the new skin allow a free circulation of the blood around and between them to feed the old epidermis, the action of the dorsal vessel follows its regular way. By and by the isolated parts of the new skin become larger, and partly united, until finally the whole new skin is already formed and chitinized. The circulation is at first only disturbed; later, it is impossible for it to flow in the old way and to the old skin, and the blood, obliged to turn in another direction, rushes naturally in the easiest one, to the dorsal vessel. This is the moment of the beginning of the rush of the blood to the head; of course the nervous system, irritated by the rush, will help to accelerate more the action of the dorsal vessel.

It is obvious that the new skin, at least in some parts of the body, must exercise a more or less strong pressure against the old skin. I am of the opinion of Dr. Gerstaecker, that the moult is not alone a consequence of such pressure; but in some parts, for instance in the head, the pressure is obviously prevalent, and must originate a partial resorption of the old epidermis, as that of the thicker sutures. At least, thus the splitting of the sutures in many insects could be explained; I say purposely in many insects, because a large number transform in a different way. In some Lepidoptera the skin of the head does not split. Mr. Trouvelot (Americ. Natur., I, p. 37) records for *Telea Polyphemus* that the skin splits transversely under the neck just at the end of the head, and perhaps in some way laterally, and probably behind or through the whole prothorax. "When about one half of the body appears the shell of the old head remains like a cap enclosing the jaws; then the worm, as if reminded of this loose skull-cap, removes it by rubbing it on a leaf."

I was able to verify Mr. Trouvelot's observation on a cast-off skin of *T. Polyphemus*. However, in the nearly related species *Att. Cecropia*, *Promethea*, *Yama-mai*, I found that the sutures of the head always split in the regular manner. According to Kirby and Spence, the manner of

splitting is not the same for all Lepidoptera. Most of them split at first the dorsum of the second and third segment of the caterpillar. *Pieris cratægi* is stated by Bonnet to split its skin only in the head; and Reaumur records for *Zygæna filipendulæ* that the caterpillar bites off pieces of the old skin and puts them aside. Besides those old observations there exists a large number of recent ones. Generally it is true that Coleoptera, Orthoptera, Pseudoneuroptera, Diptera, Hemiptera, at least the Homoptera, and the larger part of Lepidoptera, split first the frontal sutures of the head.

It is of interest that the well-known *Limulus Polyphemus* splits in the moult the frontal sutures similar to the insects, and goes out forward of the old skin. I find nothing published about the splitting of the skin of the Crustacea. But the Decapods split along the border of the cephalophorax, and are obliged in moulting to take out the parts backwards. As the systematic position of Limulus is still a matter of dispute, I think this fact is of some value.

The restlessness of the insects before the moult, and the fact that they do not need food, are easily understood. It is known that the tracheæ participate largely in the moult. At certain times the inner skin must begin to separate, and it is obvious that through it the respiration will be impeded. Perhaps this difficulty has something to do with the acceleration of the blood. Besides the tracheæ a large part of the digestive canal changes its skin; the anterior part to the ventriculus, and the posterior to the colon. Here also, at a certain time, the inner skin begins to separate, and the natural consequence will be the impossibility of taking any food, or even of ejecting the superfluum contained in the intestines.

All insects, as I stated before, go forwards out of the old skin in transformation. But I find one case of the contrary quoted by Professor Westwood (Brit. Cyclop. Article Insect, p. 844). He says that Coccus comes out backward, the wings rejected above the head.

A very remarkable fact is that the females of the Ephemerous genus Palingenia do not change the skin of the subimago. Swammerdam says the females for the most part do not change the skin; but a very large number of them examined by myself possessed the subimago skin, and I never saw one without it. They undergo copulation and lay eggs without having arrived at the state of a perfect insect.

The instances where insects in the last moult are not able to throw away the skin and carry it with them are in Ephemera not very rare, as the long setæ are sometimes fastened in the old skin. But I caught a Libellula flying with its nympha skin fastened to the end of the abdomen. The specimen, *Diplax scotica*, is still in my collection. I am indebted to Mr. A. Agassiz for a knowledge of the fact that larvæ of Radiates are sometimes found with parts of the foregoing state still attached to the skin.

ON THE PRECOCIOUS DEVELOPMENT OF THE CATERPILLAR DIRECTLY INTO THE IMAGO STATE.

Bombyx Mori.

Mr. Cesare Majoli, in Giornale di Fisica, Chemica, Storia Naturle del Regno Italico di L. Brugnatelli, Pavia, 1813, Bim. V, p. 399, describes a curious instance of a precocious development of the well-known silk-moth. The book seems to be wanting in all libraries of the United States, and is not even common in Europe. I am obliged to Professor Pelzel in Vienna, Austria, for a written copy of the notice, which I find recorded only in J. F. Meckel's Archiv f. Physiol., 1816, Vol. II, p. 542, and in Lacordaire's Introd., Vol. II, p. 443, and by Stannius in Mueller's Archiv, 1835, p. 297. As both differ from each other in some important statements and from the text, I prefer to reprint the original.

Straordinario fenomeno di anticipata trasformazione in farfalla del verme da seta.

Il Sign. A. Farini di Forli ha communicato al Sign. Barzoni un' osservazione interessante descritta dal Sign. Lettore Cesare Majoli in un opusculo M. S. sulla vita, costumi ed educazione del filugello. Sovente aveva sentito raccontare da chi educava i bachi da seta, che pure qualche volta accadeva svolgersi essi in farfalla prima che incominciassero a filare il bozzolo, cioè dopo la quarta muta. Le reputava favole femminili, giacchè nissuno aveva parlato di un tale fenomeno. Ma si è convinto del fatto nel 1792, allorchè chiamato a rendere ragione di esso trovò che due cannicci e stuoje di bruchi erano isfarfallati nella notte antecedente senza formare il bozzolo deludendo cosi la speranza del coltivatore. In qualcuno degli anni antecedenti accadde pure un somigliante fenomeno, e nel 1811 il Sign. Dott. Siboni gli mandò due di questi aborti volanti generati in una casa di proprietà della Signora Rosatti che lo stesso Sign. Farini ha osservato. Questa farfalla differisce dalla falena bombice per li seguenti caratteri. Ha il capo piccolo, due occhj neri reticolati, il torace quale se fosse il terzo anello dopo il capo del bruco; ha il corpo del bruco istesso all' epoca della quarta muta, pari numero di anelli a quello del bruco; le ali superiori alquanto lunghe e ristrette, le inferiori più corte e strette; ha le antenne alquanto cenerognole in confronto di quelle della falena vera bombice. Il Sign. Majoli espone una conghiettura sopra la cagione del fenomeno mentovato e inclina ad attribuirlo al calore eccessivo del luogo in cui esistevano què bachi da seta, per cui nel momento in cui filugello sta

per compiere la sua metamorfosi dello stato di bruco, ne altera siffattamente il sistema primitivo, ne promuove una traspirazione straordinaria de' fluidi esistenti nel bruco e soprattutto di quello che è necessario a formare il bozzolo, e ne acceleri cosè la sua metamorfosi d' isfarfallare. Sarebbe stato a desiderare che per confermare in qualche modo l' accennata opinione si fosse tentato artatamente di attenere lo stesso effetto col sottoporre diversi bruchi ad una temperatura calda, allorchè erano vicini alla quarta muta. Interessante sarebbe il sapere se le farfalle che abortirono avevano gli organi della generazione ben formati e capaci come la falena bombice di accoppiamento e di mettere le uova atte a sviluppare a suo tempo il bacolino.

[TRANSLATION.]

An extraordinary case of a precocious transformation of the caterpillar of Bombyx Mori into the moth.

Mr. A. Farini, in Forli, has communicated to Mr. Barzoni an interesting observation, published by Mr. Cesare Majoli, about the life, the manners, and the education of the silk-moth. He was told by men occupied with the breeding of silk-worms that it sometimes happens that caterpillars before spinning a cocoon, therefore after the fourth moult, were transformed into moths. He believed it to be only talk, the more so as nobody had published anything about such a case. But he convinced himself of the fact in 1792. Invited purposely to convince himself by his own observation, he saw two boards filled with caterpillars transformed in the preceding night into moths without having spun cocoons, to the regret and deception of the owner. Recently the same fact was observed, and in 1811 he received by Dr. Siboni two such winged deformities, bred by Mrs. Rosatti, and examined by Mr. Farini. These differ from the regularly developed silk-moth in the following characters: The head is small, with two black compound eyes; the thorax similar to the third segment behind the head of the caterpillar, and the abdomen similar to that of a caterpillar at the time of the fourth moult, with just as many segments as the abdomen of the caterpillar; the fore-wings somewhat elongated and narrowed; the hind-wings shorter and narrower; the antennæ grayish, compared with those of the regular silk-moth. Mr. Majoli gives an hypothesis for the cause of such a transformation, and believes it to be the excessive warm temperature of the breeding-room. The caterpillar ready for transformation is prevented by the heat from producing the exudation of the fluids which are necessary for the formation of the chrysalis, and is obliged to transform directly into the moth. To ascertain his hypothesis he should have made experiments to produce such a transformation in an artificial way, by exposing caterpillars shortly before the fourth

moult to a high temperature. It will be of interest to know if the moths possessed well-developed genital parts, fitted for copulation and for the deposition of fertile eggs.

I have given purposely, in full, the original, as the two records existing disagree on some important facts. Lacordaire seems to have seen the original, as his record contains some statements not given by Meckel. Nevertheless, he has surely seen, and partly translated, Meckel's record, as is proved by the words: "les deux yeux noirs rapprochés," a verbal translation of the "Zusammengesetzten Augen," by Meckel. The presence of fore-wings only is recorded by Meckel, of hind-wings only by Lacordaire.

The statements given by Majoli are probable, except that the thorax, which is said to be similar to the third segment of the caterpillar, has four wings. The identity of the abdomen with the abdomen of the caterpillar consists perhaps only in elongation, as the presence of other parts is not mentioned.

Lacordaire considers the fact as proving the development of certain parts of an insect by precocity, though the other parts follow the common rule of development.

The fact would be a rather interesting one if it was beyond doubt. As silk-worms are raised every year by millions, I should have supposed that the observation would have been oftener made and published. Nevertheless, it is astonishing that such a fact, filling in some way the gap between insects with an incomplete metamorphosis, and those with a complete one, is not used by evolutionists.

A paper by the well-known Lepidopterologist, Mr. E. J. C. Esper, in Hoppe. Entom. Taschenbuch (for 1796), pp. 183 – 188, which I have not at hand, may possibly treat the question of a precocious development.

Majoli's observation is briefly reproduced (after Meckel) by Professor Van der Hoeven, in his quoted paper, p. 272. He remarks that no related observations are known, and that his observation rests only upon its own merits.

DEFORMITY OF THE ELYTRA.

Strategus (Geotrupes) Julianus.

The late Professor J. Wyman observed a specimen of this large beetle flying around in Florida in 1874. The movements were in some way strange and unusual, and induced Professor J. Wyman to catch the beetle. To his astonishment he found it perfectly developed, but the elytra wanting. The specimen, preserved in alcohol, he presented shortly before his death to the collection.

The specimen is a female, of thirty-six mm. length, and perfectly developed. The wings are in good and perfect condition, but there is no trace of the elytra; which are entirely wanting on both sides. Professor J. Wyman thought at first that the elytra had been removed by somebody, and the insect put again at liberty But a careful examination of the living insect as well as of the alcoholic specimen by Dr. J. L. Leconte, and by myself, showed no lesion whatsoever in the place where the elytra should have been inserted. The anterior border of the mesothorax is horny and smooth, and near the scutellum exists a small membranous place without any wound. The legs, the prothorax, the upper part of the mesothorax, the metathorax, the scutellum, and the whole abdomen, are perfectly developed.

This case of deformity belongs to the "monstres ectroméliens" of Lacordaire, but as far as I am able to ascertain, no similar case is recorded. The fact that the beetle was able to fly without elytra is of additional interest.

Prionus coriarius.

This remarkable case is twice recorded, but later entirely overlooked. As I believe this kind of deformity of prominent value, I give a translation of the original communication by Dr. Saage in Preussische Provinzial Blaetter (1839), Vol. XXII, p. 191.

"One of my school-boys brought me to-day a male *Prionus coriarius*, the thorax of which presents a curious deformity. The horny dorsal cover of the mesothorax is wanting, and instead of elytra there are inserted, just in their place of articulation, two perfect legs, directed above and behind. The metathorax has the wings as usual, and the abdomen is of the same horny character as commonly, when covered with elytra. In attempts at flight the insect moved, together with the wings, the abnormal dorsal legs. The scutellum is wanting, and the prothorax has only two spines; all other parts are perfectly developed."

"Braunsberg, Prussia, July 10, 1839."

This communication is reprinted in Stett. Ent. Zeit., Vol. I. p. 48. The specimen was seen and examined afterwards by Professor von Siebold.

I have always considered this case to be a striking proof of the homology of the wings with the legs. No similar case has been recorded.

EXPLANATION OF THE PLATE.

FIGS. 1 – 5. — **Morpho Eurylochus.**

Fig. 1, side view. Fig. 2, the head of the same, magnified, showing beneath the separated mentum. Fig. 3, front view of the head. Fig. 4, the same from below, showing the forelegs. Fig. 5, head of the perfect imago.

FIGS. 6 – 9. — **Phalæna heteroclita.**

The figures are copied from the original in the Mémoir. Prés. Acad. Paris, Vol. VI. The plate given by Goeze is not exactly reproduced.

Fig. 6, the moth from above. Fig. 7, the same from below. Fig. 8, front view of the head. Fig. 9, the eggs.

FIGS 10, 11. — **Nymphalis Populi.**

The figures are copied from the Bull. Acad. Bruxelles, Vol. IV.

Fig. 10, the butterfly from above. Fig. 11, front view of the head.

The plate was intended to contain all figures given for this kind of deformity. When it was made, Mr. Bruinsma's paper was not known to me.

E. Konopicky del. et lith.

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